

The Drift Dark Matter Search Experiment

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A negative-ion TPC for direct detection of weakly interacting (χ) dark matter.

Collaboration:

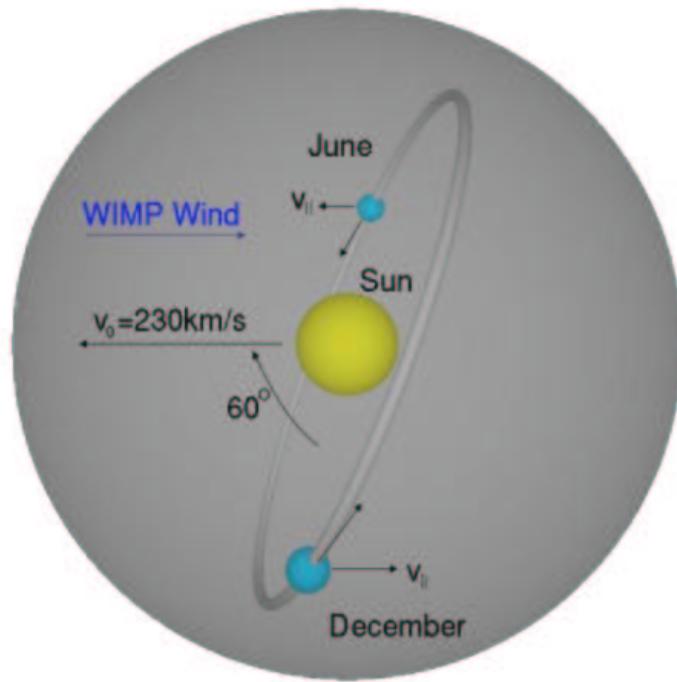
- Martoff (Temple University)
 - Snowden-Ifft (Occidental College)
 - Spooner et al. (UK Dark Matter Collaboration)
- & Drift II: U. New Mexico (Basselbeck, Boyd, Fields, Hoffman, Loomba, Matthews), Boston U. (Ahlen)

WIMP signatures

principal background is neutrons:

1. annual modulation (few %)
2. diurnal modulation ($\sim 10\%$)
3. target material (mass)

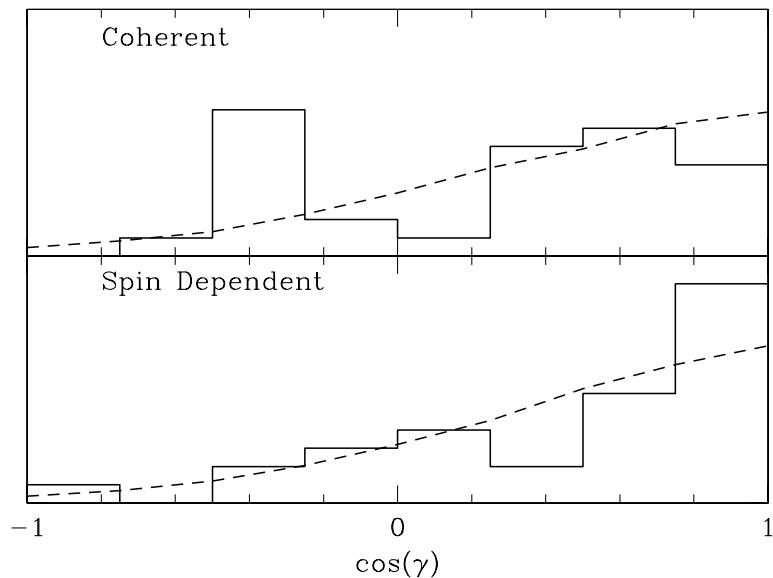
Drift can do all 3, and is the only experiment that can measure the diurnal modulation.



Diurnal Modulation

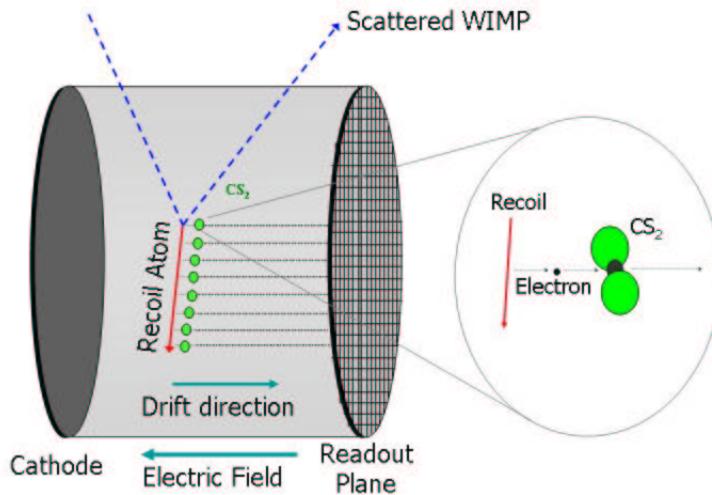
(Spergel, 1988)

$$\frac{dR}{dQdc_\gamma} \propto \exp \frac{-(vc_\gamma - v_{th})^2}{v_{halo}}$$



30 simulated χ -Xe events distributed in recoil angle γ in galactic frame (Lehner et al., astro-ph9905074)

DRIFT concept

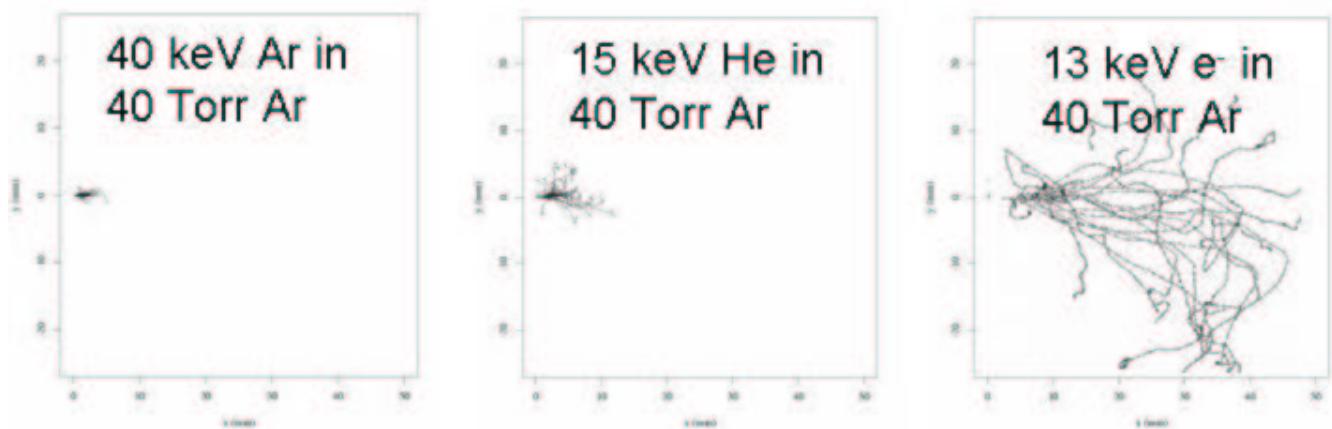


Observe tracks from $< 100\text{keV}$ nuclear recoils:

- drift of -ions (CS₂) limits diffusion without \vec{B} (Martoff)
- P (< 100 Torr) needed for few mm tracks
- MWPC 2D tracks (2mm wires + timing)
- lucite construction (minimize α radioactivity)

Background rejection (SRIM)

Simulation of 500e signals:

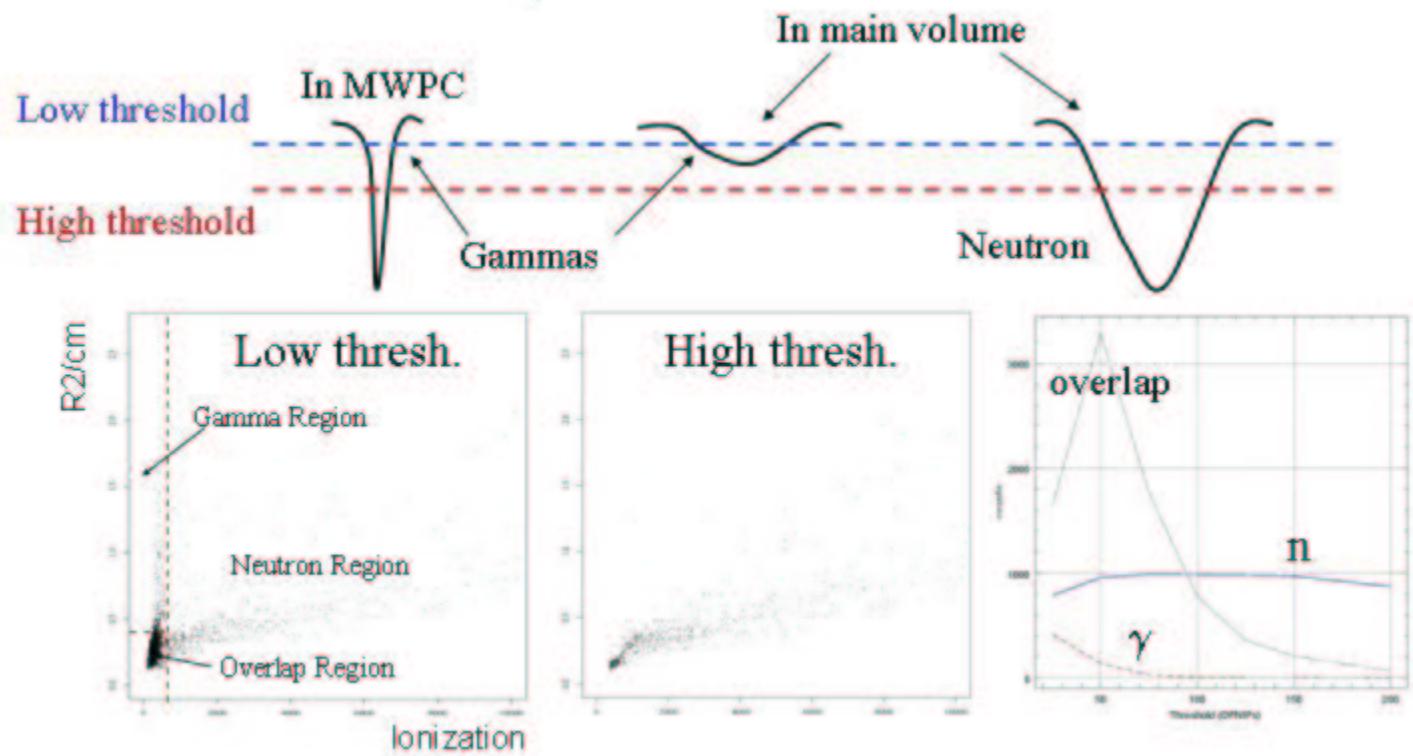


Drift I parameters:

- 1m³ active volume
- pure CS₂ 40 Torr \Rightarrow 0.16 kg of material
- expected low backgrounds:
 $> 99.9\% e/\gamma$ rejection 6 keV (< 0.03 events/y)

Drift I Operation

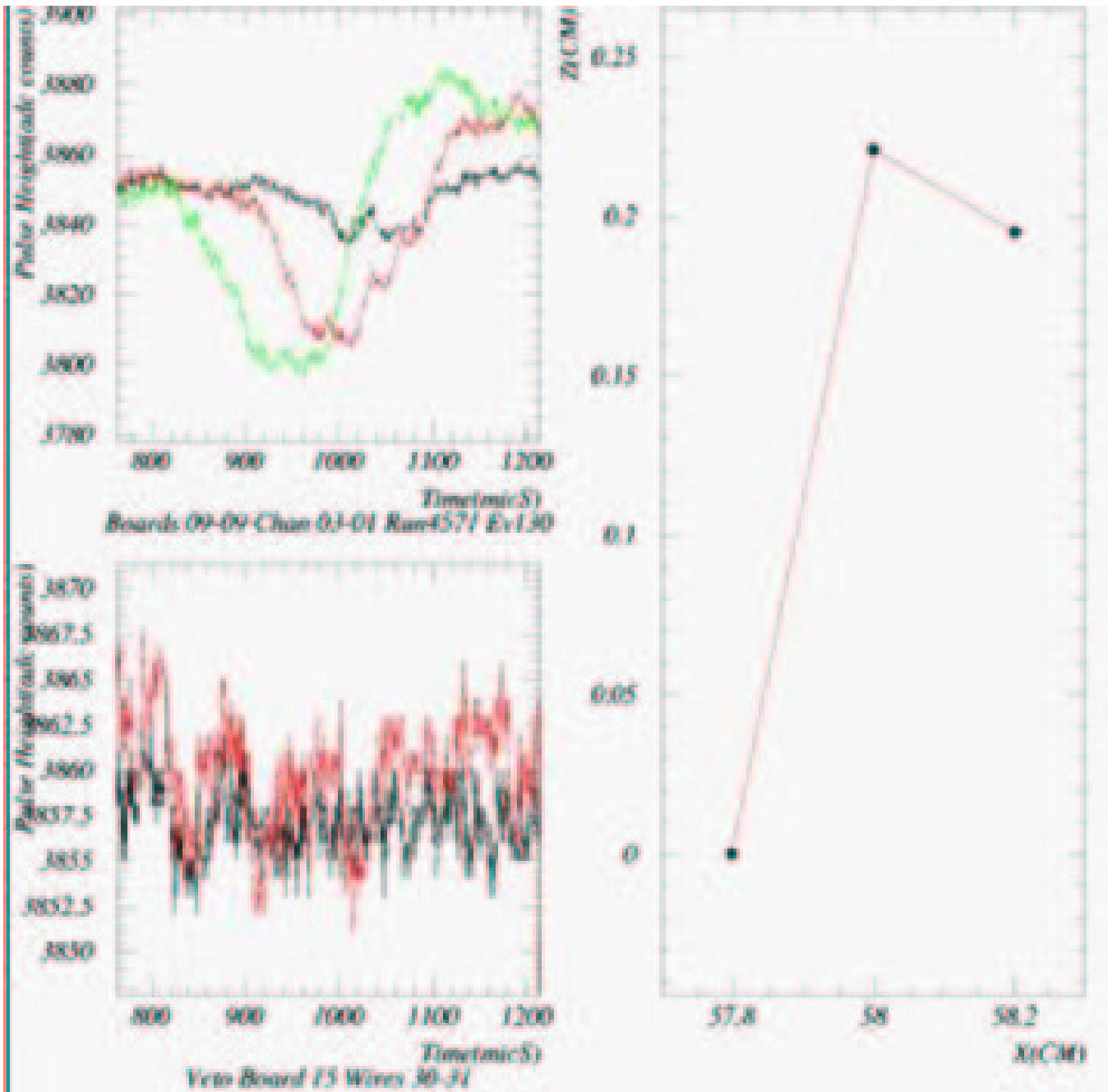
source calibration and e/γ rejection:



spark/noise events easily rejected by pulse shape plots of range versus ionization in main (-ion drift) volume.

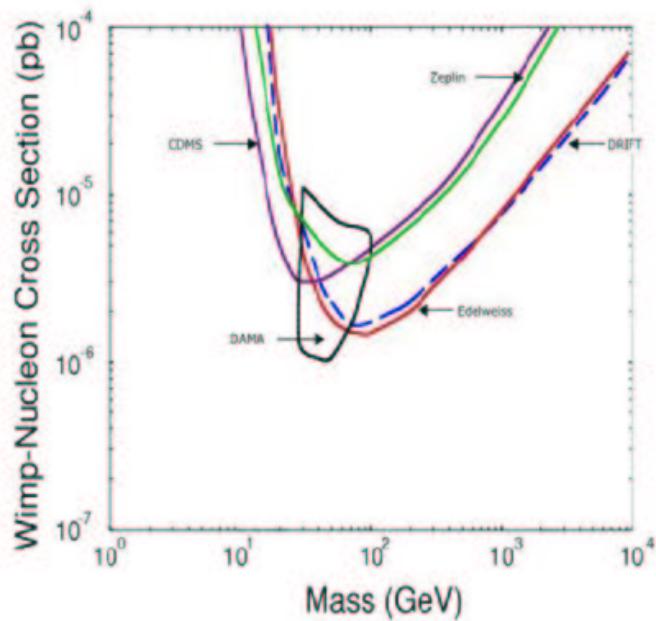
signal versus threshold: high ϵ_N with γ rejection

Neutron Calibration Event



^{252}Cf Neutron

Drift I Reach



Expected drift I sensitivity: 1 year of running with neutron shielding Drift I is now taking shielded data in Boulby mine (1100m/2800 MWE)

Drift II/III

refine design and build 3kg (Drift II) sensitive to 10^{-7} pb, scalable to 100 kg (Drift III)

- More robust TPC
- Larger volume
- deeper site
- Xe- CS_2 mixture, 0.07 kg/m^3 Xe target
- Improved track resolution (e.g. GEMS, 2d readout plane)

Gas-electron multipliers (Sauli, et al.)

